

CLAIMS:

1. A gasifier comprising:  
spaced coarse and fine fuel inlet ports;  
a fixed bed gasification section where coarse fuel is gasified;  
an entrained flow gasification section where fine fuel is gasified; and  
a gas effluent port where gases generated from coarse fuel and fine fuel are  
collectively discharged.

5 2. The gasifier according to claim 1, wherein the fixed bed gasification section  
comprises:

10 an upper fixed bed section that receives coarse fuel from the coarse fuel inlet in  
which the coarse fuel is devolatilized to form volatilized gases which flow downward;  
and  
a lower fixed bed section.

15 3. The gasifier according to claim 2, further comprising:

an internal cross-section constriction in the upper fixed bed section; and  
an upper plenum disposed adjacent said constricted cross-section.

20 4. The gasifier according to claim 3, wherein effluent gas from the fixed bed  
gasification section and the entrained flow gasification section collect within the upper plenum  
and wherein the gas effluent site is located adjacent the upper plenum.

25 5. The gasifier according to claim 4, wherein the upper plenum is configured to  
provide an effluent gas residence time and operating temperature sufficient to crack tars and oils  
contained within the effluent gas.

30 6. The gasifier according to claim 2, wherein the upper fixed bed section is  
configured to operate at a temperature which converts a portion of the coarse fuel into activated  
carbon.

7. The gasifier according to claim 6, wherein activated carbon is entrained with the effluent gas.

5 8. The gasifier according to claim 7, further comprising an activated carbon collector to capture and remove activated carbon entrained in the effluent gas.

9. The gasifier according to claim 6, further comprising an activated carbon removal port to permit removal of activated carbon from the fixed bed gasification section.

10. The gasifier according to claim 9, further comprising a screw device in combination with the activated carbon removal port to permit removal of activated carbon.

11. The gasifier according to claim 1, wherein the entrained flow gasification section disposed in a lower plenum adjacent the lower fixed bed section which volatilizes fine fuel.

12. The gasifier according to claim 1, wherein fine fuel is fed into the entrained flow gasification section by at least one tangentially fired burner.

20 13. The gasifier according to claim 12, wherein the fine fuel is selected from pulverized solid fuel, liquid fuel, gaseous fuel, and combinations thereof.

14. The gasifier according to claim 1, wherein a portion of the fine fuel is sized to ensure incomplete carbon combustion of the fine fuel which results in the generation of activated 25 carbon particles entrained with the effluent gas.

15. The gasifier according to claim 14, further comprising an activated carbon collector to capture and remove activated carbon entrained in the effluent gas.

16. The gasifier according to claim 1, which generates activated carbon entrained in the effluent gas, further comprising an activated carbon collector to capture and remove activated carbon from the effluent gas, further comprising pollution control equipment which contacts the effluent gas with said activated carbon to capture and remove pollutants from the effluent gas.

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17. The gasifier according to claim 16, wherein the pollutants are selected from sulfur compounds, halogen compounds, and heavy metals.

18. The gasifier according to claim 1, further comprising a plurality of injection ports configured to introduce oxygen, steam, or air into different regions of the gasifier.

19. The gasifier according to claim 18, wherein the injection ports are configured to facilitate temperature control within the gasifier.

20. The gasifier according to claim 18, wherein the injection ports are configured to control the steam to oxygen ratio within the gasifier.

21. The gasifier according to claim 18, wherein the injection ports are configured to control the hydrogen to carbon monoxide ratio within the gasifier.

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22. The gasifier according to claim 18, wherein the injection ports are configured to control the amount of oxygen, steam, or air in different sections of the gasifier to promote a partial water gas shift reaction.

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23. The gasifier according to claim 22, wherein the injection ports are configured to control the amount of oxygen, steam, or air in different sections of the gasifier to control the temperature and to promote a methanation reaction.

24. The gasifier according to claim 1, configured to simultaneously process coarse fuel in the fixed bed gasification section and fine fuel in the entrained flow gasification section.

25. The gasifier according to claim 1, wherein the fine fuel is selected from pulverized solid fuel, liquid fuel, gaseous fuel, and combinations thereof.

5 26. The gasifier according to claim 1, further comprising a plurality of pulsating jets disposed about the lower fixed bed section which agitate coarse fuel or ash within the fixed bed section.

10 27. The gasifier according to claim 26, wherein the pulsating jets inject pressurized gas pulses.

15 28. The gasifier according to claim 27, wherein the gas pulses comprise pulses of air, oxygen, steam, carbon dioxide, gaseous fuel, or recycled effluent gas.

29. The gasifier according to claim 1, configured to operate using only coarse fuel in the fixed bed gasification section.

30. A gasifier having a two-stage fixed bed gasification section and an entrained flow  
gasification section comprising:

a coarse fuel inlet;

5 a two-stage fixed bed gasification section that receives coarse fuel from the coarse  
fuel inlet, said fixed bed gasification section comprising:

an upper fixed bed section in which the coarse fuel is devolatilized to form  
volatilized gases which flow downward;

an internal cross-section constriction in the upper fixed bed section;

a lower fixed bed section; and

an upper plenum disposed adjacent the internal cross-section constriction;

an entrained flow gasification section disposed in a lower plenum adjacent the  
lower fixed bed section which volatilizes fine fuel, wherein fine fuel is fed into the  
entrained flow gasification section by at least one tangentially fired burner;

15 a plurality of injection ports configured to introduce oxygen, steam, or air into  
different sections of the gasifier;

a plurality of pulsating jets disposed about the lower fixed bed section which  
agitate coarse fuel or ash within the fixed bed section; and

20 a gas effluent site from which gases obtained from the coarse and fine fuels are  
collectively discharged, wherein effluent gas from the fixed bed gasification section and  
the entrained flow gasification section collect within the upper plenum and wherein the  
gas effluent site is located adjacent the upper plenum.

31. The gasifier according to claim 30, wherein the fine fuel is selected from

pulverized solid fuel, liquid fuel, gaseous fuel, and combinations thereof.

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32. The gasifier according to claim 30, wherein the injection ports are configured to  
facilitate temperature control within the gasifier.

30 33. The gasifier according to claim 30, wherein the injection ports are configured to  
control the steam to oxygen ratio within the gasifier.

34. The gasifier according to claim 30, wherein the injection ports are configured to control the hydrogen to carbon monoxide ratio within the gasifier.

5 35. The gasifier according to claim 30, wherein the injection ports are configured to control the amount of oxygen, steam, or air in different sections of the gasifier to promote a partial water gas shift reaction.

10 36. The gasifier according to claim 35, wherein the injection ports are configured to control the amount of oxygen, steam, or air in different sections of the gasifier to control the temperature and to promote a methanation reaction.

15 37. The gasifier according to claim 30, wherein the upper fixed bed section is configured to operate at a temperature which converts a portion of the coarse fuel into activated carbon.

20 38. The gasifier according to claim 37, wherein activated carbon is entrained with the effluent gas.

39. The gasifier according to claim 38, further comprising an activated carbon collector to capture and remove activated carbon entrained in the effluent gas.

40. The gasifier according to claim 37, further comprising an activated carbon removal port to permit removal of activated carbon from the fixed bed gasification section.

25 41. The gasifier according to claim 40, further comprising a screw device in combination with the activated carbon removal port to permit removal of activated carbon.

42. The gasifier according to claim 30, wherein a portion of the fine fuel is sized to ensure incomplete carbon combustion of the fine fuel which results in the generation of activated carbon particles entrained with the effluent gas.

5 43. The gasifier according to claim 42, further comprising an activated carbon collector to capture and remove activated carbon entrained in the effluent gas.

44. The gasifier according to claim 30, which generates activated carbon entrained in the effluent gas, further comprising an activated carbon collector to capture and remove activated carbon from the effluent gas, further comprising pollution control equipment which contacts the effluent gas with said activated carbon to capture and remove pollutants from the effluent gas.

45. The gasifier according to claim 44, wherein the pollutants are selected from sulfur compounds, halogen compounds, and heavy metals.

46. The gasifier according to claim 30, wherein the pulsating jets inject pressurized gas pulses.

20 47. The gasifier according to claim 46, wherein the gas pulses comprise pulses of air, oxygen, steam, carbon dioxide, gaseous fuel, or recycled effluent gas.

48. The gasifier according to claim 30, configured to simultaneously process coarse fuel in the fixed bed gasification section and fine fuel in the entrained flow gasification section.

25 49. The gasifier according to claim 30, configured to operate using only coarse fuel in the fixed bed gasification section.

50. The gasifier according to claim 30, wherein the upper plenum is configured to provide an effluent gas residence time and operating temperature sufficient to crack tars and oils contained within the effluent gas.

51. A gasifier comprising:

a coarse fuel inlet;

a two-stage fixed bed gasification section that receives coarse fuel from the coarse fuel inlet, said fixed bed gasification section comprising:

5 an upper fixed bed section in which the coarse fuel is devolatilized to form volatilized gases which flow downward;

an internal cross-section constriction in the upper fixed bed section;

a lower fixed bed section; and

an upper plenum disposed adjacent the internal cross-section constriction;

10 a plurality of injection ports configured to introduce oxygen, steam, or air into different sections of the gasifier, wherein a portion of the ports are located adjacent the coarse fuel inlet; and

15 a gas effluent site from which gases obtained from the coarse fuel is discharged, wherein effluent gas from the fixed bed gasification section collect within the upper plenum and wherein the gas effluent site is located adjacent the upper plenum.

20 52. The gasifier according to claim 51, wherein the upper plenum is configured to provide an effluent gas residence time and operating temperature sufficient to crack tars and oils contained within the effluent gas.

25 53. The gasifier according to claim 51, wherein the upper fixed bed section is configured to operate at a temperature which converts a portion of the coarse fuel into activated carbon.

30 54. The gasifier according to claim 53, wherein activated carbon is entrained with the effluent gas.

55. The gasifier according to claim 54, further comprising an activated carbon collector to capture and remove activated carbon entrained in the effluent gas.

56. The gasifier according to claim 53, further comprising an activated carbon removal port to permit removal of activated carbon from the fixed bed gasification section.

57. The gasifier according to claim 56, further comprising a screw device in combination with the activated carbon removal port to permit removal of activated carbon.

58. The gasifier according to claim 51, which generates activated carbon entrained in the effluent gas, further comprising an activated carbon collector to capture and remove activated carbon from the effluent gas, further comprising pollution control equipment which contacts the effluent gas with said activated carbon to capture and remove pollutants from the effluent gas.

59. The gasifier according to claim 58, wherein the pollutants are selected from sulfur compounds, halogen compounds, and heavy metals.

60. The gasifier according to claim 51, further comprising a plurality of injection ports configured to introduce oxygen, steam, or air into different regions of the gasifier.

61. The gasifier according to claim 60, wherein the injection ports are configured to facilitate temperature control within the gasifier.

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62. The gasifier according to claim 60, wherein the injection ports are configured to control the steam to oxygen ratio within the gasifier.

63. The gasifier according to claim 60, wherein the injection ports are configured to 25 control the hydrogen to carbon monoxide ratio within the gasifier.

64. The gasifier according to claim 60, wherein the injection ports are configured to control the amount of oxygen, steam, or air in different sections of the gasifier to promote a partial water gas shift reaction.

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65. The gasifier according to claim 64, wherein the injection ports are configured to control the amount of oxygen, steam, or air in different sections of the gasifier to control the temperature and to promote a methanation reaction.

5        67. The gasifier according to claim 51, further comprising a plurality of pulsating jets disposed about the lower fixed bed section which agitate coarse fuel or ash within the fixed bed section.

10      68. The gasifier according to claim 67, wherein the pulsating jets inject pressurized gas pulses.

69. The gasifier according to claim 68, wherein the gas pulses comprise pulses of air, oxygen, steam, carbon dioxide, gaseous fuel, or recycled effluent gas.

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70. A method of gasifying a carbonaceous fuel feedstock comprising the steps of:  
feeding coarse fuel into a gasifier having a two-stage fixed bed gasification  
section comprising:  
an upper fixed bed section that receives the coarse fuel, wherein the upper  
fixed bed section operates at a temperature sufficient to devolatilize the coarse  
fuel and form volatilized gases which flow downward;  
an internal cross-section constriction in the upper fixed bed section;  
a lower fixed bed section; and  
an upper plenum disposed adjacent said constricted cross-section;  
introducing oxygen, steam, or air into the upper fixed bed section and lower fixed  
bed section control the temperature within the gasifier; and  
withdrawing effluent gas from the gasifier.

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71. The method of gasifying carbonaceous fuel according to claim 70, wherein the amount of oxygen, steam, or air introduced into the fixed bed gasification section is varied to control the steam to oxygen ratio within the gasification chamber.

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72. The method of gasifying carbonaceous fuel according to claim 70, wherein the amount of oxygen, steam, or air introduced into the fixed bed gasification section is varied to control the hydrogen to carbon monoxide ratio within the gasifier.

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73. The method of gasifying carbonaceous fuel according to claim 70, wherein the amount of oxygen, steam, or air introduced into the fixed bed gasification section is varied to promote a partial water gas shift reaction.

74. The method of gasifying carbonaceous fuel according to claim 73, wherein the amount of oxygen, steam, or air introduced into the fixed bed gasification section is varied to control the temperature and to promote a methanation reaction.

75. The method of gasifying carbonaceous fuel according to claim 70, further comprising the step of feeding fine fuel into an entrained flow gasification section where the fine fuel is gasified.

5 76. The method of gasifying carbonaceous fuel according to claim 75, wherein the entrained flow gasification section is disposed in a lower plenum adjacent the lower fixed bed section.

10 77. The method of gasifying carbonaceous fuel according to claim 75, wherein fine fuel is fed into the entrained flow gasification section by at least one tangentially fired burner.

15 78. The method of gasifying carbonaceous fuel according to claim 70, wherein effluent gas from the fixed bed gasification section collects within the upper plenum and wherein the effluent gas is withdrawn from the upper plenum.

20 79. The method of gasifying carbonaceous fuel according to claim 78, further comprising the step of maintaining the effluent gas within the upper plenum for a sufficient gas residence time and operating temperature to crack tars and oils contained within the effluent gas.

25 80. The method of gasifying carbonaceous fuel according to claim 70, wherein the upper fixed bed section is operated at a temperature which converts a portion of the coarse fuel into activated carbon.

81. The method of gasifying carbonaceous fuel according to claim 80, wherein activated carbon is entrained with the effluent gas.

25 82. The method of gasifying carbonaceous fuel according to claim 81, further comprising the step of capturing and removing activated carbon entrained in the effluent gas.

83. The method of gasifying carbonaceous fuel according to claim 80, further comprising the step of removing activated carbon from the fixed bed gasification section.

84. The method of gasifying carbonaceous fuel according to claim 75, wherein a portion of the fine fuel is sized to ensure incomplete carbon combustion of the fine fuel which results in the generation of activated carbon particles entrained with the effluent gas.

85. The method of gasifying carbonaceous fuel according to claim 84, further comprising the step of capturing and removing activated carbon entrained in the effluent gas.

86. The method of gasifying carbonaceous fuel according to claim 70, further comprising the steps of:

generating activated carbon;

capturing and removing activated carbon from either the effluent gas or lower fixed bed section;

introducing activated carbon and effluent gas into pollution control equipment wherein the activated carbon contacts the effluent gas and captures and removes pollutants from the effluent gas.

87. The method of gasifying carbonaceous fuel according to claim 86, wherein the pollutants are selected from sulfur compounds, halogen compounds, and heavy metals.

88. The method of gasifying carbonaceous fuel according to claim 86, wherein the pollution control equipment comprises a baghouse.

89. A method of producing activated carbon in a gasifier device comprising the steps of:

feeding coarse fuel into a gasifier having a fixed bed gasification section comprising:

5 an upper fixed bed section that receives the coarse fuel, wherein the upper fixed bed section operates at a temperature sufficient to devolatilize the coarse fuel and form volatilized gases which flow downward;

an internal cross-section constriction in the upper fixed bed section; and a lower fixed bed section through which volatilized gases flow upward;

introducing oxygen, steam, or air into the upper fixed bed section and lower fixed bed section control the temperature within the gasifier, wherein the upper fixed bed section is operated at a temperature which converts a portion of the coarse fuel into activated carbon.

10 90. The method of producing activated carbon according to claim 89, further comprising the step of withdrawing effluent gas from the gasifier, wherein the activated carbon is entrained with the effluent gas.

15 91. The method of producing activated carbon according to claim 90, further comprising the step of capturing and removing activated carbon entrained in the effluent gas.

92. The method of producing activated carbon according to claim 89, further comprising the step of removing activated carbon from the fixed bed gasification section.

20 93. The method of producing activated carbon according to claim 89, further comprising the step of feeding fine fuel into an entrained flow gasification section where the fine fuel is gasified, wherein a portion of the fine fuel is sized to ensure incomplete carbon combustion of the fine fuel which results in the generation of activated carbon particles entrained with the effluent gas.

94. The method of producing activated carbon according to claim 93, further comprising the step of capturing and removing activated carbon entrained in the effluent gas.

95. The method of producing activated carbon according to claim 93, wherein the  
5 entrained flow gasification section is disposed in a lower plenum adjacent the lower fixed bed  
section.

96. A method for removing vapor phase pollutants from effluent gas produced by the  
gasification of carbonaceous fuel, wherein the gasification of carbonaceous fuel also produces  
activated carbon as a byproduct, said method comprising the steps of:

supplying that activated carbon sorbent to a baghouse having a filter bag therein  
until the filter bag is coated with a layer of sorbent; and

introducing the effluent gas into the baghouse, wherein a sufficient amount of  
activated carbon sorbent is supplied to the baghouse to coat the filter bag and facilitate  
intimate contact between the activated carbon sorbent and vapor phase pollutants and thus  
removing vapor phase pollutants from the effluent gas.

97. A gasifier that produces activated carbon comprising:  
a coarse and fuel inlet port;  
a fixed bed gasification section where coarse fuel is gasified and which is  
configured to operate at a temperature that devolatilizes coarse fuel to form volatilized  
5 gases, said fixed bed gasification section further comprising a carbon activation zone  
configured to operate at a temperature that destroys and cracks tars and oils remaining in  
the volatilized gases and coarse fuel, thereby converting the coarse fuel into activated  
carbon;  
a plurality of injection ports configured to introduce oxygen, steam, or air into  
10 different sections of the gasifier to control operating conditions within the gasifier; and  
a gas effluent port where gases generated from coarse fuel are discharged.

15 98. The gasifier that produces activated carbon according to claim 97, wherein the  
discharged gases comprise entrained activated carbon and further comprising an activated carbon  
collector to capture and remove activated carbon entrained in the discharged gases.

20 99. The gasifier that produces activated carbon according to claim 97, further  
comprising an activated carbon removal port to permit removal of activated carbon from the  
fixed bed gasification section.

25 100. A gasifier that produces activated carbon comprising:  
a fine fuel inlet port;  
an entrained flow gasification section where fine fuel is gasified, wherein a  
portion of the fine fuel is sized to ensure incomplete carbon combustion of the fine fuel  
which results in the generation of activated carbon particles entrained with the effluent  
gas; and  
a gas effluent port where gases generated from fine fuel are discharged, wherein  
the discharged gases comprise entrained activated carbon.